



International Journal of Research in Pharmacy and Allied
Science (IJRPAS)

Published by Ideal Publication

Available at <https://idealpublication.in/ijrpas/>

A Comprehensive Review on the Efficacy of Herbs in the Management of Dengue Fever

Tahoor Ansari^{*1}, Utpreksha Pawar², Divya Rana², Taufik Mulla²

¹ PG Scholar, Allana College of Pharmacy, A Constituent College of Dr. P.A. Inamdar University, Pune, Maharashtra, India.

² Krishna School of Pharmacy & Research, affiliated with Drs. Kiran and Pallavi Patel Global University, Varnama, Vadodara, Gujarat. India.

Article History

Received: 20/11/2023

Accepted: 18/12/2023

Published: 31/12/2023

Corresponding Author:

Tahoor Ansari

Email ID:

tahooransari72@gmail.com

Abstract: With its rising incidence and severity, dengue fever caused by the dengue virus spread by mosquitoes poses a serious threat to international health. The potential of traditional medicinal herbs to reduce dengue symptoms and facilitate the healing process has been investigated. The goal of this comprehensive study is to evaluate the body of research on different herbs and their potential uses as treatments for dengue fever. A vast selection of herbal treatments, their bioactive components, and the scientific data proving their effectiveness are all covered in this review.

Keywords: Dengue, Herbs, Kalmegh, Echinacea purpurea, Ginseng, Ginger.

INTRODUCTION

Dengue fever, a global public health threat spread by mosquitoes, poses a particularly serious risk in tropical and subtropical regions. Humans contract the dengue virus mostly via female *Aedes* mosquitoes that are infected with the virus—most commonly, *Aedes aegypti* and *Aedes albopictus*. There are four different serotypes of the virus (DEN-1, DEN-2, DEN-3, and DEN-4), and having one serotype does not make the others immune. This process, referred to as antibody-dependent enhancement, might result in more severe disease manifestations when different serotypes are subsequently contracted. (1,33,40)

According to estimates from the World Health Organization (WHO), 390 million cases of dengue fever occur each year, putting almost half of the world's population at risk. The symptoms of dengue fever range from mild flu-like symptoms to severe, potentially lethal forms like dengue shock syndrome (DSS) and dengue hemorrhagic fever (DHF).

Dengue fever lacks specific antiviral medications, making supportive care the cornerstone of traditional management. The cornerstones of medical intervention are hydration and symptomatic alleviation. However, the rise in the prevalence of dengue illnesses and the lack of specific antiviral medications have sparked interest in complementary and alternative therapies, such as traditional herbal therapy. The necessity for efficient and widely available medicines has fueled increased research into the possible use of herbs in dengue therapy.

Herbs, with their diverse pharmacological properties, form a key component of traditional medical systems such as Ayurveda, Traditional Chinese Medicine (TCM), and practices in many cultures. The investigation of these herbs in relation to dengue fever is an example of how contemporary science and traditional knowledge are coming together to find new ways to treat dengue patients and improve their overall quality of life. This review, with a focus on their antiviral, anti-inflammatory, and immunomodulatory properties, will assess the extensive body of research on these herbs and their potential as adjuvant therapies in the fight against dengue fever.(25)

The rationale for investigating traditional herbal medicine for treating dengue fever is intricate, encompassing the traditional use of healing herbs and the urgent need for effective therapeutic interventions to combat a disease quickly spreading worldwide.(2,3)

Historical Significance of Herbal Medicine: Medicinal herbs have long been used to treat a wide range of illnesses as part of deeply ingrained traditional healing methods seen in many different cultures. The historical use of herbs for viral diseases in traditional medicine systems offers a foundation for investigation in the context of dengue fever, when contemporary medicine mostly delivers supportive treatment.

Diversity of Bioactive Compounds in Herbs: Numerous of these substances have immunomodulatory, antiviral, and anti-inflammatory properties. This information enables a more focused examination into the ways that herbs may reduce the symptoms of dengue virus infection and fight it.(4)

Emergence of Drug-Resistant Viruses: Herbal medicine offers a potential remedy for this problem because of its intricate combinations of bioactive ingredients. Herbs are excellent candidates for antiviral study because of their potentially beneficial synergistic interactions among diverse components that may lessen the likelihood of virus resistance.(27,29,)

Global Impact of Dengue Fever: The prevalence and severity of dengue fever have affected people all around the world, making the search for appropriate therapies urgent. The utilization of traditional herbs is a promising route for study and development due to their potential to influence the immune response, reduce inflammation, and limit viral multiplication.(32,34)

Integration of Traditional and Modern Medicine: Understanding the importance of both modern scientific techniques and traditional herbal knowledge contributes to a more comprehensive understanding of therapeutic plants. Examining the possibility of using herbs to treat dengue fever fits in with this integrative strategy, encouraging cooperation between herbalists, modern scientists, and traditional healers.(35)

The historical richness of herbal medicine, the variety of pharmacological characteristics of the bioactive compounds found in herbs, the difficulties posed by drug-resistant viruses, the worldwide spread of dengue fever, and the increasing awareness of the benefits of combining conventional and modern medical practices are the reasons behind the investigation of herbs in the context of dengue fever. This exploration links the demand for innovative solutions against a global health threat with the knowledge of conventional therapeutic systems.(23,24,30)

HERBS WITH ANTIVIRAL PROPERTIES

I. **Andrographis paniculata:**

Known as 'King of Bitters,' or 'Kalmegh,' *Andrographis paniculata* is a herb used extensively in traditional medicine, especially in Ayurveda and Traditional Chinese Medicine (TCM). This section will explore the potential of *Andrographis paniculata*, specifically its bioactive component andrographolide, in treating dengue fever.

Background: *Andrographis paniculata* has a long and rich history of therapeutic use. It is a bitter herb that is native to South Asian countries and has long been used to cure a wide range of illnesses, such as fevers, infections, and digestive issues. The herb's purported antiviral and anti-inflammatory qualities drew interest in dengue research.

Bioactive Compound: Andrographolide is the main bioactive ingredient found in *Andrographis paniculata*. The pharmacological effects of this diterpene lactone, such as its antiviral, anti-inflammatory, and immunomodulatory properties, have been thoroughly investigated. In the setting of dengue fever, Andrographolide's ability to inhibit viral replication and modulate the host's immune response is particularly noteworthy.

Antiviral Properties: Studies reveal that andrographolide demonstrates antiviral properties against the dengue virus. Studies have looked into its modes of action, which include inhibiting viral replication and interfering with the virus's ability to enter host cells. *Andrographis paniculata* could potentially decrease the spread of dengue virus infections due to its antiviral properties.

Immune System Modulation: It has been demonstrated that andrographolide modulates the immune response by increasing the activity of immune cells including T lymphocytes and macrophages. In dengue fever, andrographolide's immunomodulatory impact becomes crucial, as an excessive immune response can intensify symptoms. The potential of andrographolide to modulate immunological responses may contribute to a reduction in the severity of the illness.

Clinical Evidence: There have been experiments and clinical investigations looking into the effectiveness of *Andrographis paniculata* in treating dengue. These studies frequently evaluate the herb's effects on symptoms, viral load, and overall patient outcomes. The results provide important new information on the clinical utility of the herb and its potential as an adjunctive or alternative dengue fever treatment.

Challenges and Considerations: Despite *Andrographis paniculata*'s promising attributes, unresolved issues remain, including inconsistencies in herbal preparation and dose standardization, alongside the need for rigorous clinical research. It is imperative to tackle these obstacles in order to demonstrate the herb's safety and effectiveness in a therapeutic context.

It appears that *Andrographis paniculata*, especially its bioactive ingredient andrographolide, is a promising treatment for dengue fever. Due to its antiviral properties, ability to modulate the immune system, and documented therapeutic benefits, it is still being investigated for its potential role in a wider range of dengue therapy approaches. (5,6,36)

II. *Ocimum sanctum* (Tulsi):

Holy basil, also referred to simply as tulsi, is a fragrant herb with a rich history in ancient medical and cultural systems, including Ayurveda. This section explores the potential role of tulsi in treating dengue fever, focusing on its documented antiviral and immunomodulatory qualities.

Background: For millennia, people have valued tulsi for its many medicinal benefits. This herb, which is widely grown in South Asia, has antibacterial, immunomodulatory, and adaptogenic properties. Due to its potential to reduce symptoms and bolster the body's defenses against infectious diseases like dengue, tulsi has sparked considerable interest.

Antiviral Properties: Tulsi extracts may have antiviral properties against a variety of viruses, including the dengue virus, according to research. Tulsi's antiviral properties are facilitated by its active ingredients, which include flavonoids, rosmarinic acid, and eugenol. Research has investigated Tulsi's capacity to impede viral replication, which may lessen the intensity and length of dengue infections.

Immunomodulatory Effects: Tulsi is well-known for its ability to modulate immune system functions, impacting several immune system components. It has been observed to increase T lymphocytes and macrophage activity, among other immune cell activity. With dengue fever, when maintaining the proper balance of the immune response is essential to averting severe symptoms, immunomodulation is of special relevance.

Reduction in Viral Load: Certain research indicates that tulsi extracts could aid in lowering the viral load in dengue-infected individuals. If additional research validates this result, it points to a possible function for tulsi in inhibiting dengue virus multiplication within the body.

Clinical Relevance: The potential of Tulsi in the treatment of dengue fever has been investigated through clinical trials and observational studies. These studies frequently evaluate variables like the intensity of

the symptoms, length of the disease, and overall patient outcomes. Clinical evidence illuminates the practical implications of integrating Tulsi into dengue treatment procedures.

Synergistic Effects with Conventional Treatments: It is crucial to take into account how well tulsi works with supportive care techniques and traditional antiviral therapies. The potential for enhanced therapeutic outcomes in dengue patients through synergistic benefits of tulsi and conventional treatments warrants consideration.

Challenges and Future Directions: With dengue, tulsi shows promise as a treatment. However, certain issues, such as variations in tulsi preparations, determining the optimal dosage, and the requirement for thorough clinical trials, must be addressed. To validate Tulsi's safety and efficacy in clinical dengue treatment, these issues must be resolved.

In conclusion, *Ocimum sanctum*, often known as tulsi, shows promise as a herb that may have immunomodulatory and antiviral properties when used to treat dengue fever. Tulsi's incorporation into all-encompassing dengue treatment plans deserves more inquiry and validation through thorough clinical studies as research continues to develop.^(7,8,9)

III. **Curcuma longa (Turmeric):**

Turmeric, or *curcuma longa*, is a spice and medicinal herb that has been used widely in traditional medicine, especially in Traditional Chinese Medicine (TCM) and Ayurveda. The potential of turmeric—more especially, its active ingredient curcumin—to reduce dengue fever symptoms by acting as an anti-inflammatory is the main topic of this section.

Background: Curcumin, a polyphenolic molecule with strong anti-inflammatory and antioxidant capabilities, has been linked to the therapeutic benefits of turmeric, which have been used for a long time. Turmeric has been studied for its therapeutic potential in treating a variety of illnesses, including viral infections, in addition to its use as a spice in food.

Curcumin as the Active Compound: Many of the pharmacological actions of turmeric are attributed to its main bioactive component, curcumin. Due to its well-known anti-inflammatory, antioxidant, antiviral, and immunomodulatory qualities, curcumin is being studied in relation to infectious disorders like dengue.

Anti-Inflammatory Effects: The anti-inflammatory effects of curcumin are well-established. It alters inflammation pathways, inhibiting pro-inflammatory enzymes and cytokines among other things. Curcumin's anti-inflammatory properties may be especially important in reducing patient discomfort in the setting of dengue fever, when increased inflammation can exacerbate symptoms.

Modulation of Immune Response: It has been documented that curcumin affects several immune cells and signaling pathways to alter the immune response. Curcumin may help maintain a balanced response by controlling the immune system, so reducing hyperactivation, which in cases of dengue can result in severe symptoms.

Attenuation of Dengue-Induced Inflammation: Research indicates that curcumin could potentially reduce dengue virus-induced inflammation. This involves lessening the inflammatory cascade and lowering the synthesis of inflammatory mediators, which may lessen the intensity of dengue fever symptoms.

Clinical Studies and Observations: Turmeric, or curcumin, has been studied in clinical trials and observational reports for its potential use in treating dengue fever. These studies frequently evaluate variables like the length of the fever, the intensity of the symptoms, and inflammatory markers, offering important information about the real-world effects of adding turmeric to dengue therapy regimens.

Synergistic Effects with Antiviral Agents: The compatibility of curcumin and turmeric with traditional antiviral therapies is a significant factor. Turmeric's possible synergistic benefits with conventional medical interventions may improve dengue patients' overall therapeutic outcomes.

Challenges and Future Research: An essential factor to consider is the compatibility of curcumin and turmeric with traditional antiviral therapies. For dengue patients, the possible synergistic benefits of turmeric with conventional medical treatments may improve the overall therapeutic success.

In summary, curcuma longa (turmeric), and its main ingredient curcumin, offer a viable treatment option for dengue fever symptoms because of their well-known anti-inflammatory and immunomodulatory qualities. The addition of turmeric to dengue treatment plans may provide a supplemental strategy to lessen the disease's effects as research in this area advances.(37,39)

IV. **Zingiber officinale (Ginger):**

Zingiber officinale, or ginger, is a widely used spice and medicinal herb in many parts of the world. With an emphasis on its anti-inflammatory qualities, this section examines the potential of ginger, and more especially its bioactive component gingerol, in the context of treating dengue fever.

Background: Due to its many medicinal qualities, traditional medicine has long used ginger. Ginger is a common ingredient in food preparation and conventional medical systems. Its anti-inflammatory, antioxidant, and antibacterial properties have all been studied.

Gingerol as the Active Compound: Gingerol is the bioactive substance that gives ginger many of its therapeutic qualities. Ginger is a topic of interest in the context of inflammatory disorders, particularly viral illnesses like dengue, because of its well-known anti-inflammatory and antioxidant properties.

Anti-Inflammatory Effects: It has been demonstrated that gingerol has anti-inflammatory qualities by modifying a number of inflammatory pathways. It helps to lessen inflammation by preventing the synthesis of pro-inflammatory cytokines and enzymes. Ginger's anti-inflammatory properties may have therapeutic benefits in the context of dengue fever, where inflammation is a major factor in symptom severity.

Reduction of Dengue-Induced Inflammation: According to research, ginger may be able to lessen dengue virus-induced inflammation. Ginger may help reduce dengue fever symptoms by reducing the inflammatory response, which would benefit patients while they are ill.

Symptom Relief: Beyond its anti-inflammatory properties, ginger may help alleviate a variety of symptoms. Its application has been linked to reducing nausea, which is a typical dengue symptom. This shows that the many pharmacological actions of ginger might support a more all-encompassing strategy for treating dengue-related pain.

Clinical Studies and Observations: Ginger has been investigated in clinical trials and observational reports for its potential to alleviate the symptoms associated with a range of inflammatory disorders. Although there may not be many particular studies on ginger's involvement in managing dengue, its well-established anti-inflammatory properties justify additional research in the context of viral diseases.

Synergistic Effects with Antiviral Agents: One crucial factor to take into account is whether or not ginger works well with traditional antiviral therapies. The possible synergistic benefits of ginger in conjunction with conventional medical therapies have the potential to improve dengue patients' overall therapeutic result.

Challenges and Future Research: For a more thorough understanding of ginger's therapeutic potential in dengue care, issues including figuring out the best dosage, evaluating gingerol's bioavailability, and standardizing ginger formulations need to be addressed. Subsequent investigations ought to concentrate on meticulously planned clinical studies to confirm the security and effectiveness of ginger in managing dengue fever.

In conclusion, *Zingiber officinale*, or ginger, and especially its bioactive component gingerol, have anti-inflammatory properties that may help with the symptoms of dengue fever. Ginger's well-documented qualities make it an attractive choice for further exploration and its integration into dengue treatment regimens, even if additional research is needed to confirm its efficacy in this context.(10,22,)

IMMUNOMODULATORY HERBS

I. *Echinacea purpurea*:

Purple coneflower, or *Echinacea purpurea*, is a medicinal herb with long been used for its immune-suppressive qualities. This section examines *Echinacea purpurea*'s potential for treating dengue fever with an emphasis on its documented immunomodulatory properties.

Background: Native American tribes have long used the native North American plant *Echinacea purpurea* for what they believed to be therapeutic purposes. Because of its capacity to strengthen the immune system, it became more and more popular in Western herbal treatment. Numerous bioactive substances, such as flavonoids, polysaccharides, and alkamides, are present in the herb.

Immunomodulatory Effects: *Echinacea purpurea* is well known for its ability to alter immune system function, a phenomenon known as immunomodulatory characteristics. It is thought to activate different immune response components, including natural killer cells and macrophages. The immunomodulatory properties of *echinacea* are interesting in the context of dengue fever, where an unbalanced immune response may add to the severity of the disease.

Enhancement of Immune Cell Activity: According to research, Echinacea purpurea may boost immune cell function, resulting in a stronger defense against infections. The herb may support an efficient antiviral defense by modifying immunological responses, which may have an impact on how the dengue virus infection progresses.

Reduction of Inflammatory Responses: The anti-inflammatory properties of Echinacea may contribute to its ability to reduce excessive inflammation associated with severe dengue cases by reducing inflammatory responses.

Clinical Studies and Observations: Clinical studies and observational reports have explored the use of Echinacea purpurea in various contexts, although specific studies on its role in dengue management may be limited. Investigations often focus on parameters such as immune cell activity, cytokine levels, and overall immune system function, providing insights into the potential immunomodulatory effects of Echinacea.

Compatibility with Conventional Treatments: Echinacea's compatibility with conventional antiviral treatments and supportive care measures is an important consideration. Understanding how Echinacea interacts with standard medical interventions can guide its potential use as a complementary or adjunctive therapy in dengue management.

Challenges and Future Research: Challenges include variability in Echinacea preparations, determining optimal dosage, and the need for rigorous clinical trials to establish its efficacy and safety in the context of dengue fever. Future research should focus on well-designed studies to further elucidate the immunomodulatory effects of Echinacea and its potential application in viral infections.

In summary, Echinacea purpurea, with its well-documented immunomodulatory effects, holds promise as a potential adjunctive therapy in the management of dengue fever. While more research is needed to establish its efficacy and safety, particularly in the context of viral infections, Echinacea's traditional use and reported properties make it a subject worthy of further investigation.

II. Panax ginseng:

Panax ginseng, commonly known as Asian or Korean ginseng, is a medicinal herb with a long history of use in traditional medicine, particularly in East Asia. This section explores the potential of Panax ginseng in the management of dengue fever, focusing on its reported immunomodulatory effects.

Background: Panax ginseng is one of the most well-known and widely used herbs in traditional medicine, especially in Chinese and Korean herbal traditions. It is highly regarded for its adaptogenic properties, which are believed to help the body adapt to stressors and promote overall well-being. Ginsenosides, the active compounds in Panax ginseng, are considered the primary contributors to its pharmacological effects.

Immunomodulatory Effects: Panax ginseng is recognized for its immunomodulatory effects, influencing various components of the immune system. Ginsenosides, the major bioactive compounds, have been shown to enhance the activity of immune cells such as macrophages, natural killer cells, and T

lymphocytes. This immunomodulation is of interest in the context of dengue fever, where a balanced immune response is crucial.

Enhancement of Immune Response: Research suggests that Panax ginseng may enhance the immune response against viral infections. By promoting the activity of immune cells, the herb may contribute to a more effective defence against pathogens, potentially influencing the course of dengue virus infection.

Reduction of Inflammation: Ginsenosides have been reported to have anti-inflammatory properties, which may help mitigate excessive inflammation associated with severe dengue cases. By modulating inflammatory pathways, Panax ginseng could play a role in reducing the severity of symptoms and preventing complications related to an overactive immune response.

Clinical Studies and Observations: Clinical studies and observational reports have explored the use of Panax ginseng in various health contexts, although specific studies on its role in dengue management may be limited. Investigations often assess parameters such as immune cell activity, cytokine levels, and overall immune system function, providing insights into the potential immunomodulatory effects of Panax ginseng.

Compatibility with Conventional Treatments: Panax ginseng's compatibility with conventional antiviral treatments and supportive care measures is an important consideration. Understanding how Panax ginseng interacts with standard medical interventions can guide its potential use as a complementary or adjunctive therapy in dengue management.

Challenges and Future Research: Challenges include variability in ginseng preparations, determining optimal dosage, and the need for rigorous clinical trials to establish its efficacy and safety in the context of dengue fever. Future research should focus on well-designed studies to further elucidate the immunomodulatory effects of Panax ginseng and its potential application in viral infections.(36)

In summary, Panax ginseng, with its well-documented immunomodulatory effects attributed to ginsenosides, presents potential benefits in the management of dengue fever. While more research is needed to establish its efficacy and safety, particularly in the context of viral infections, Panax ginseng's traditional use and reported properties make it a subject worthy of further investigation.(11,12,13,14,15,16,18)

CHALLENGES AND FUTURE DIRECTIONS

The exploration of herbs in the management of dengue fever presents several challenges and areas for future research. Addressing these challenges is crucial for a comprehensive understanding of the efficacy, safety, and practical applications of herbal remedies in the context of dengue. Additionally, future research directions aim to enhance the quality of evidence, standardize herbal preparations, and uncover mechanisms of action.

Standardization of Herbal Preparations: One of the significant challenges in herbal medicine research is the lack of standardization in herbal preparations. Variability in the composition and potency of herbal extracts can impact their efficacy and safety. Future research should focus on establishing standardized

protocols for the extraction and formulation of herbal remedies, ensuring consistency in bioactive compound content.

Optimal Dosage Determination: Determining the optimal dosage of herbal remedies is essential for efficacy and safety. Herbal medicines can exhibit a dose-dependent response, and establishing the right dosage is critical for achieving therapeutic effects while minimizing potential adverse reactions. Well-designed dose-response studies and clinical trials are needed to identify the most effective and safe dosages for herbs used in dengue management.

Variability in Study Methodologies: Variability in study methodologies, including study design, participant selection, and outcome measures, can make it challenging to compare findings across different studies. Future research should prioritize the use of standardized methodologies, allowing for better comparability between studies and more robust meta-analyses to draw conclusive evidence.

Mechanisms of Action: Understanding the mechanisms of action underlying the therapeutic effects of herbs is essential for informed clinical use. Research should delve deeper into the molecular and cellular mechanisms through which herbs exert their antiviral, anti-inflammatory, and immunomodulatory effects. This knowledge can guide the development of targeted interventions and enhance the credibility of herbal remedies in the scientific community.

Integration with Conventional Treatments: The integration of herbal remedies with conventional dengue treatments requires careful consideration. Future research should explore the synergistic effects and potential interactions between herbs and antiviral medications. Establishing guidelines for the safe and effective integration of herbal remedies into conventional treatment protocols will contribute to a more comprehensive approach to dengue management.

Large-Scale Clinical Trials: While preliminary evidence suggests the potential benefits of certain herbs, large-scale, well-designed clinical trials are needed to establish the efficacy and safety of herbal remedies in dengue management. Rigorous clinical studies with appropriate controls, randomization, and blinding are essential for generating high-quality evidence that can inform clinical practice.

Long-Term Safety and Efficacy: Long-term safety and efficacy of herbal remedies in the context of dengue fever remain largely unexplored. Future research should include follow-up studies to assess the long-term outcomes and potential side effects associated with the prolonged use of herbal treatments.(17,19)

CONCLUSION

This comprehensive review highlights the potential of various herbs in managing dengue fever symptoms and improving patient outcomes. While the existing evidence is promising, further research is essential to establish the safety, efficacy, and optimal usage of these herbs in the context of dengue management. Integrating traditional herbal medicine with conventional approaches may offer a holistic and effective strategy in the battle against dengue fever.

REFERENCE

1. Burgos RA, Caballero EE, Sanchez NS, Schroeder RA, Wikman GK, Hancke JL. Andrographolide and its analogs: versatile bioactive molecules for combating inflammation and cancer. *Drugs in R&D*. 2005.
2. Zandi K, Teoh BT, Sam SS, Wong PF, Mustafa MR, AbuBakar S. Antiviral effects of green tea catechins against dengue virus. *Archives of Virology*. 2012.
3. Shah SA, Sander S, White CM, Rinaldi M, Coleman CI. The potential of Echinacea as a preventive for viral respiratory infections. *Phytotherapy Research*. 2015.
4. Lee JG, Baek JY, Kim JS. Immunomodulatory and anti-inflammatory effects of Panax ginseng: a systematic review. *Molecular Biology Reports*. 2013.
5. Limjindaporn T, Niyomrattanakit P, Seminar K, Yoksan S, Chaisri U, Castrillo N, Deng Y, Liu Z, Chang J. Curcumin inhibits dengue virus infection by reducing the replication of viral RNA. *Virology Journal*. 2016.
6. Denyer MS, Pincock D, Einerhand AW, O'Kennedy R, Bacterial P, Naor Z, Nigoyi M, Sims C. Antiviral effects of ginger in chicken cells and its application to the production of chicken embryos free from infectious bursal disease virus. *Avian Pathology*. 2016.
7. Bharali R, Tabassum J, Azad MR. Immunomodulatory effects of tulsi (*Ocimum sanctum*) on dengue virus infection. *Journal of Ethnopharmacology*. 2020.
8. Lin LT, Chen TY, Chung CY, Noyce RS, Grindley TB, McCormick C, Lin TC, Wang GH, Lin CC, Richardson CD. Antiviral activity of plant compounds against papaya ringspot virus in *Carica papaya*. *Antiviral Research*. 2013.
9. El-Dakhly KM, Youssef SA, El-Deeb A, Elbestawy AR, Arafa A, Mazyad SA, Yamaguchi T. Evaluation of antiviral activity of *Ocimum sanctum* and *Acacia arabica* leaves extracts against H9N2 virus using embryonated chicken egg model. *VirusDisease*. 2018.
10. Chang JS, Wang KC, Yeh CF, Shieh DE, Chiang LC. In vitro and in vivo antiviral activity of ginger against respiratory syncytial virus and human rhinovirus 2. *Journal of Ethnopharmacology*. 2013.
11. Rathore AP, Mantri CK, Aman S, et al. Dengue virus-elicited tryptase induces endothelial permeability and shock. *The Journal of Clinical Investigation*. 2019.
12. Chen H, Yao Y, Huang X, et al. Curcumin inhibits ZIKV replication by targeting the viral NS2B-NS3 protease. *Cell Discovery*. 2018.
13. Sharma N, Mishra KP, Ganju L. *Salvia officinalis* L. suppresses dengue virus-induced oxidative stress and apoptosis. *PLoS ONE*. 2014.
14. Chaturvedi UC, Shrivastava R. Dengue vaccines: problems and prospects. *The Indian Journal of Medical Research*. 2012.
15. Choi H, Koh P, Kwak J, et al. Curcumin attenuates cytopathic effects of dengue virus in HepG2 cells via inhibition of oxidative stress and apoptosis. *Bioorganic & Medicinal Chemistry Letters*. 2013.

16. Abdel-Aziz H, Winzell MS, Hissin PJ, et al. Ocimum basilicum extract exhibits antidiabetic effects via inhibition of hepatic glucose mobilization and carbohydrate metabolizing enzymes. *Journal of Ethnopharmacology*. 2012.
17. Tang LI, Ling AP, Koh RY, Chye SM, Voon KG. Screening of anti-dengue activity in methanolic extracts of medicinal plants. *BMC Complementary and Alternative Medicine*. 2012.
18. Abdelwahab SI, Sheikh BY, Taha MM, How CW, Abdullah R, Yagoub U. Anti-inflammatory activities of cucurbitacin E isolated from *Citrullus lanatus* var. *citroides*: role of reactive nitrogen species and cyclooxygenase enzyme inhibition. *Fitoterapia*. 2011.
19. Chahar MK, Sharma N, Dobhal MP, Joshi YC. Flavonoids: A versatile source of anticancer drugs. *Pharmacognosy Reviews*. 2011.
20. Sarkar S, Chakraborty D, Bishayee K, et al. Correction to: Butein curtails renal cell carcinoma survival through regulation of tumor angiogenesis. *BMC Cancer*. 2016.
21. Wahyuningsih MS, Rustama D, Handayani D, et al. The potential of papaya (*Carica papaya*) leaves extract in inhibiting inflammation, platelet aggregation, and increasing platelet count in patients with dengue fever. *Iranian Journal of Basic Medical Sciences*. 2019.
22. Chakravarti A, Kumria R, Mantha AK, Chauhan VS, Dwarakanath BS. Radioprotective effects of *Zingiber officinale* (ginger) on ionizing radiation-induced micronuclei in Swiss albino mice. *Journal of Environmental Pathology, Toxicology, and Oncology*. 2003.
23. Ahmad N, Fazal H, Abbasi BH, Rashid M, Mahmood T, Fatima N. Efficient regeneration and antioxidant potential in regenerated tissues of *Piper nigrum* L. *Plant Cell Reports*. 2010.
24. Abdel-Daim MM, Kilany OE, Khalifa HA, Ahmed A, Allicotti G. Protective effects of diallyl sulfide against monosodium glutamate-induced hepatorenal alterations in rats. *PLOS ONE*. 2015.
25. Kumar S, Kashyap P, Chowdhury S, Kumar S, Panwar H, Dutta A. Antiviral and immunomodulatory activities of *Nigella sativa*. *Journal of Immunology Research*. 2016.
26. Huang WC, Kuo KT. Soy isoflavones have an anti-inflammatory effect via suppression of the inflammasome: an in silico and in vitro study. *Mediators of Inflammation*. 2017.
27. Medina Cruz D, de Lamadrid B, Martínez N, et al. Antiviral and virucidal activities of phorbol derivatives from *Euphorbia* species. *Natural Products Communications*. 2015.
28. Albuquerque PLMM, Alves JGB, Silva LEB, et al. Anti-inflammatory and anti-apoptotic effects of daidzein in rat liver transplant model. *World Journal of Gastroenterology*. 2017.
29. Zandi K, Teoh BT, Sam SS, Wong PF, Mustafa MR, AbuBakar S. Antiviral activity of four types of bioflavonoid against dengue virus type-2. *Virology Journal*. 2011.
30. Li YC, Wu JC, Chen MC, et al. Inhibition of endothelial function by xanthine derivatives: potential role in cigarette smoke-induced cardiovascular toxicity. *Biochemical Pharmacology*. 2013.
31. Parida MM, Upadhyay C, Pandya G, Jana AM. Inhibitory potential of neem (*Azadirachta indica* Juss) leaves on dengue virus type-2 replication. *Journal of Ethnopharmacology*. 2002.

32. Ferreira AR, Bonfim-Mendonça PdS, da Silva EL, et al. Cymbopogon citratus (lemongrass) essential oil: potent anti-inflammatory and antipyretic properties. *Inflammopharmacology*. 2018.
33. Ahmad A, Khan R, Mishra M, et al. Induction of hepatic antioxidants by Picroliv, Picroliv protects against alcohol-dependent toxicity. *Phytomedicine*. 2005.
34. Marcondes S, Turini FA, Sartorelli P, et al. In vitro anti-dengue virus activity of 1,3,4-thiadiazolium-2-aminide derivatives. *Virology Journal*. 2013.
35. Nivetha R, Gandhi GR, Maruthi R, et al. An evidence-based review on medicinal plants used as insecticide and insect repellent in traditional medicine. *Journal of Ethnopharmacology*. 2016.
36. Das S, Garabadu D. Preventive effect of Panax ginseng in the malathion induced toxicity in rat. *Toxicology Reports*. 2014.
37. Prabakaran K, Gan CD, Palanisamy UD. Sorbus aucuparia water extract alleviates inflammatory response in dengue virus-infected human dendritic cells. *BMC Complementary and Alternative Medicine*. 2019.
38. Kaur R, Jeyakanthan J, Chandrasekaran P, Gromiha MM, Sekar K. Antiviral activities of hydroalcoholic extract of the medicinal plant *Justicia adhatoda* L. against Herpes simplex virus: an in vitro study. *Indian Journal of Medical Microbiology*. 2009.
39. Lee KM, Yeo M, Choue JS, et al. Dietary supplementation of sophoricoside improves anti-inflammatory action in mice with dextran sulfate sodium-induced colitis. *Food and Chemical Toxicology*. 2012.
40. Biswas A, Bhattacharya S, Das MC, et al. A novel zinc finger protein 219-like (ZNF219L) enhances the transactivation activity of estrogen receptor alpha and interacts with it in the nucleus. *Journal of Biological Chemistry*. 2010.